



Innovation in Mathematics Learning Through E-Learning Ethnomathematics: Creative Thinking Skills and Learning Outcomes

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Abstract

This study aims to develop ethnomathematics-based e-learning with a touch of Lampung cultural design and analyze its influence on students' creative thinking skills and learning outcomes in a number of materials. E-learning based on ethnomathematics was developed using the Branch development model with stages of development, implementation, and evaluation. The research sample consisted of 80 students selected through purposive sampling techniques. The data collection instrument was an essay test to measure students' creative thinking skills and learning outcomes. The data were analyzed using an independent sample t-test statistical test with the help of SPSS 25 software. The results of the analysis showed that the t-value for creative thinking skills (14.426) and learning outcomes (13.921) were higher than the t table (1.990) at a significance level of 0.05. This indicates a significant difference between the experimental and control groups. The average increase in creative thinking skills reached 67.5%, while student learning outcomes increased by 65.0%. This e-learning enhances the originality and elaboration aspects of creative thinking and provides a learning experience that enriches mathematical knowledge through the Lampung cultural context. E-learning based on ethnomathematics with Lampung design offers innovation in digital learning that is not only adaptive to the needs of the 21st century but also supports the preservation of local culture in the educational process. This study recommends ethnomathematics-based e-learning as an alternative learning medium that effectively improves creative thinking skills and student learning outcomes while introducing Lampung culture more broadly in an academic context.

Keywords: Creative Thinking; Education; Ethnomathematics; Learning Outcome

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INTRODUCTION

Creative thinking skills are one of the main competencies in 21st-century education that are essential to face complex and dynamic global challenges. 21st-century education focuses on mastering basic knowledge and developing high-level thinking skills, including creativity, critical thinking,

collaboration, and communication (4C) (Bangun, & Praghlapati, 2021; Berkinbayeva et al., 2023; Thornhill-Miller et al., 2023; Furqon et al., 2024). Creative thinking involves the ability to generate new ideas, see problems from multiple perspectives, and find innovative solutions in various situations (Dell'Era et al., 2020; Pande & Bharathi, 2020; Guaman-Quintanilla et al., 2023; Lungu et al., 2025). Rosen, Stoeffler, & Simmering (2020) added that the creative process in education includes the stages of imagination, idea development, experimentation, and evaluation. This shows that creativity is not only about initial ideas but also involves the process of maturing ideas to their implementation in authentic contexts. In the context of learning, information technology plays an essential role in enhancing student creativity. Chen et al., (2022) state that technology provides access to extensive learning resources, facilitates the visualization of abstract concepts, and creates a more interactive and adaptive learning environment. Information technology allows students to explore various ideas through digital applications, utilize mind-mapping software for thinking fluency, and utilize simulations or educational games to develop thinking flexibility (Tang et al., 2022; Fang, Abdallah, & Vorfolomeyeva, 2024; Gao et al., 2025; Spaska et al., 2025). Emphasized that through various innovative approaches, such as project-based learning and technology integration, 21st-century education is expected to be able to produce a generation that is not only academically intelligent but also creative, adaptive, and ready to face future challenges.

In addition to creative thinking skills, learning outcomes are an essential variable in this study. Learning outcomes reflect the achievement of student competencies after following the learning process, including cognitive, affective, and psychomotor aspects (Enoch et al., 2022; Abbasi et al., 2023; Akmam et al., 2024; Galdonez, 2025). Learning outcomes are influenced by various factors, including learning methods, media used, and student motivation levels. In this study, the improvement in learning outcomes will be measured through understanding mathematical concepts, applying concepts in real situations, and active student involvement in the learning process. Thus, the improvement in learning outcomes is measured by academic grades and students' ability to practice the knowledge they have acquired (Kang, & Kim, 2021; Goss, 2022; Shu, & Gu, 2023; Ikhsan et al., 2025; Isaeva et al., 2025).

One innovative approach to utilizing technology in learning is integrating ethnomathematics with Lampung design nuances in online scrabble learning media. Ethnomathematics is an approach that connects mathematical concepts with local culture to improve creative thinking skills and student learning outcomes (Prahmana, & D'Ambrosio, 2020; Nusrial et al., 2024; Arkabaev et al., 2025; Harmaini et al., 2025; Muchlis et al., 2025). E-learning based on ethnomathematics utilizes digital technology to present learning materials that are not only informative but also interesting and easily accessible. Interactive features such as videos, animations, and adaptive quizzes in e-learning can help students understand mathematical concepts while staying connected to local cultural values (Huang et al., 2021; Dede, Akcakin, & Kaya, 2022; Schotte et al., 2022; Nguyen, & Tran, 2023; Suhernawati et al., 2025). This approach allows students to analyze, find patterns, and create creative solutions based on their cultural context, thus training critical thinking skills and strengthening divergent thinking skills (Groyecka et al., 2020; Liu et al., 2021; Okolie et al., 2022; Castro, 2025; Hajrulla et al., 2025).

However, although various studies have shown the effectiveness of technology and ethnomathematics in improving creative thinking skills and student learning outcomes, several research gaps still need to be addressed. First, most studies focus more on the general application of technology in learning. Still, few specifically examine the effectiveness of ethnomathematics-based e-learning in developing creative thinking and student learning outcomes, especially in mathematics learning. Second, previous studies discuss creativity in general without delving into specific aspects such as fluency, flexibility, originality, and detail in the ethnomathematics-based learning process. Third, much of the e-learning today is still limited to delivering information without allowing students to apply knowledge in real situations related to the local cultural context. Fourth, minimal research still uses quantitative or qualitative approaches in measuring the impact of ethnomathematics-based e-learning on improving creative thinking skills and student learning outcomes in mathematics learning. Fifth, research on integrating ethnomathematics in technology-based learning media, especially in the context of local culture such as Lampung design in online scrabble games, is still very limited.

Based on these gaps, this study aims to develop e-learning scrabble based on ethnomathematics with Lampung design nuances that can improve creative thinking skills and student learning outcomes. This study will also measure the effectiveness of e-learning in the mathematics learning process and identify factors that support and hinder its implementation in the classroom. Thus, the results of this study are expected to not only provide significant contributions to the development of innovative teaching materials based on local wisdom but also provide empirical evidence regarding the effectiveness of e-learning based on ethnomathematics in improving creative thinking skills and student learning outcomes. In addition, this study supports creating 21st-century learning that is interactive, adaptive, and relevant to students' cultural context, as well as being a bridge between science and culture in forming a creative and competitive generation.

RESEARCH METHODS

There are 3 stages of Branch (2009) in this research model, namely (1) Development, (2) Implementation, and (3) Evaluation, which will be explained in more detail as follows:

At the development stage, the ethnomathematics learning media with Lampung design nuances is made into a software design. Experts validate the development of e-learning to test the validity of the product, and the final result of the e-learning development process is the e-learning design that will be implemented using the following method.

At the implementation stage, e-learning uses the prepared application implemented simultaneously with its role and function as e-learning that can facilitate ethnomathematics-based learning on number material with the hope that system users can use it well and improve students' understanding of the number material that will be delivered. In addition, e-learning can facilitate students in terms of mobile-based use and can be carried anywhere without having to bring printed student learning media. The final result of the implementation process is the ability to think creatively and the learning outcomes in ethnomathematics-based learning in a number of materials using learning media with applications that can help the learning process for students.

At the evaluation stage, the process involves using tests to assess students' creative thinking skills and learning outcomes when using e-learning based on ethnomathematics with Lampung design nuances. This study's content validity is conducted through consultation with experts (Expert Assessment Validation Criteria) in their fields. The validity test involved media experts. Content validity can be seen from the product's suitability to the curriculum's demands (Ivers & Barron, 2002), using assessment criteria such as those in Table 1 below.

Table 1. Validation criteria

Interval	Category
0.0 – 25.0	Very Inadequate
25.1 – 50.0	Not Feasible
50.1 – 75.0	Worthy
75.1 – 100.0	Very Decent

Construct validity concerns the construct or structure and psychological characteristics of the aspects to be measured by the instrument. Does the construct explain the differences in individual activities or behaviors regarding the measured aspects. This study used 80 junior high school students, who were obtained using purposive sampling techniques. Purposive sampling selects samples based on specific criteria (Kerlinger, 2014).

The first activity that must be carried out in the data collection process is to create an e-learning framework and resources, then enter all resources and e-learning frameworks into the application, after being entered into the application, a validation test is carried out by experts to see the feasibility of ethnomathematics-based e-learning, after the expert validity test is complete. The results are obtained and applied in learning to see the ability to think creatively and student learning outcomes in learning using an

essay test that has been made totaling 10 questions with a weight of 4 for the maximum score and 0 for the minimum score. The categories can be seen in Table 2.

Table 2. Category Creative thinking ability and student learning outcomes

Interval	Category
0.0 – 10.0	Very Not Good
10.1 – 20.0	Not Good
20.1 – 30.0	Good
30.1 – 40.0	Very Good

Data obtained through essay test were analyzed using inferential statistics with t test (Independent sample t-test) with the help of SPSS 25 computer program. While perception questionnaire data were analyzed using descriptive statistics assisted by SPSS 25 computer program.

RESULTS AND DISCUSSION

The results of the research conducted by this researcher are modifications to e-learning scrabble based on ethnomathematics with Lampung design nuances that can improve creative thinking skills and student learning outcomes in number material using applications. In Indonesia, learning activities are usually carried out using printed activity sheets. Therefore, researchers innovate by creating electronic activity sheets based on applications used for students studying number material. Along with advancing information technology, teaching materials used in the learning process are developed and innovated to improve education.

One of the beneficiaries of information technology is the world of education. Electronic-based learning media (e-learning) has various advantages in supporting a more effective, efficient, and adaptive learning process to technological developments. One of its main advantages is ease of accessibility, where students and teachers can access learning materials anytime and anywhere through digital devices. In addition, electronic learning media offers interactive and varied content, such as videos, animations, simulations, and interactive quizzes that can increase students' interest and motivation to learn. Electronic-based learning media can provide a more interesting and interactive learning experience, thus helping students understand the material more deeply. Another advantage lies in the flexibility of independent learning, where students can learn according to their own pace and learning style. On the teacher's side, this media allows for more creative delivery of materials and facilitates evaluating and monitoring student development through analytical features (Christopoulos, & Sprangers, 2021; Tian, 2021; Firmansyah et al., 2024; Melinda et al., 2024; Susana & Nwanya, 2024; Wang, & Li, 2024). Thus, electronic-based learning media not only enriches learning methods but also becomes an innovative solution in facing the challenges of education in the digital era. Information technology is an essential factor that enables students to speed up their knowledge transformation. Research utilizing information and communication technology, one of which is the development of printed media into electronic-based media, is better known as e-learning. The final form of the modified e-learning is as follows.

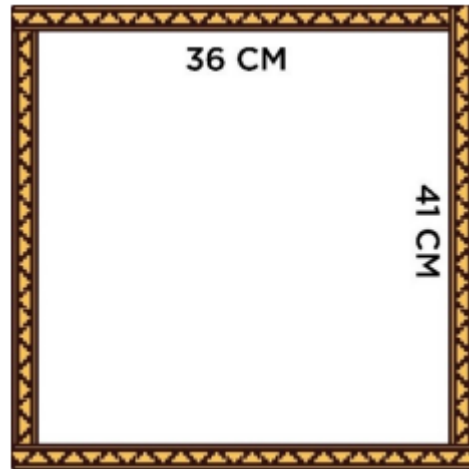


Figure 1. E-learning background display



Figure 2. Design of Scrabble letter display based on ethnomathematics

ATURAN Scrabmath

1. Permainan ini dimainkan oleh 2-4 pemain (tidak lebih, tidak lebih dari 4) yang duduk di sekitar meja. Pemain yang pertama kali memulai permainan adalah pemain yang memilih kata pertama.
2. Pemain yang memulai permainan harus memulai dengan kata yang panjangnya minimal 3 huruf dan maksimal 7 huruf. Kata tersebut harus menggunakan huruf-huruf yang ada pada papan.
3. Pemain yang memulai permainan harus memulai dengan kata yang panjangnya minimal 3 huruf dan maksimal 7 huruf. Kata tersebut harus menggunakan huruf-huruf yang ada pada papan.
4. Pemain yang memulai permainan harus memulai dengan kata yang panjangnya minimal 3 huruf dan maksimal 7 huruf. Kata tersebut harus menggunakan huruf-huruf yang ada pada papan.
5. Pemain yang memulai permainan harus memulai dengan kata yang panjangnya minimal 3 huruf dan maksimal 7 huruf. Kata tersebut harus menggunakan huruf-huruf yang ada pada papan.
6. Pemain yang memulai permainan harus memulai dengan kata yang panjangnya minimal 3 huruf dan maksimal 7 huruf. Kata tersebut harus menggunakan huruf-huruf yang ada pada papan.
7. Pemain yang memulai permainan harus memulai dengan kata yang panjangnya minimal 3 huruf dan maksimal 7 huruf. Kata tersebut harus menggunakan huruf-huruf yang ada pada papan.
8. Pemain yang memulai permainan harus memulai dengan kata yang panjangnya minimal 3 huruf dan maksimal 7 huruf. Kata tersebut harus menggunakan huruf-huruf yang ada pada papan.
9. Pemain yang memulai permainan harus memulai dengan kata yang panjangnya minimal 3 huruf dan maksimal 7 huruf. Kata tersebut harus menggunakan huruf-huruf yang ada pada papan.
10. Pemain yang memulai permainan harus memulai dengan kata yang panjangnya minimal 3 huruf dan maksimal 7 huruf. Kata tersebut harus menggunakan huruf-huruf yang ada pada papan.

Triple Word

Triple Letter

Double Letter

Double Word

Double Letter

Figure 3. Scrabmath Game Rules

E-learning based on ethnomathematics to improve creative thinking skills and student learning outcomes on application-based number material was first validated by experts. The results can be seen in table 3.

Table 3. Results from expert validation of e-learning

No	Aspect	Feasibility Level	Category
1	Theory	87.4	Very Decent
2	Display	85.3	
3	Language	86.5	

From the validation results carried out by experts, it was found that the very feasible category for the material aspect had a feasibility level of 87.4, the display aspect was 85.3 with a very feasible category, and the language aspect had a feasibility level of 86.5, which means very feasible. Therefore, based on the validation results by experts, it can be concluded that ethnomathematics-based e-learning to improve students' creative thinking skills and learning outcomes in number material using applications is very feasible and good to use. After ethnomathematics-based e-learning to enhance students' creative thinking skills and learning outcomes in number material using applications was modified, e-learning was implemented in a small group of students in learning number material to see students' creative thinking skills and learning outcomes. Practical activities are more effective in encouraging students from the acquisition of the abilities they will have (Haryanto et al., 2020; Sun, Hu, & Zhou, 2021; Gomez-del Rio & Rodriguez, 2022; Kurniawati et al., 2024; Marito et al., 2024). The following presents the results of creative thinking abilities and student learning outcomes analyzed using descriptive statistics shown in Table 4.

Table 4. The gap in scores for implementing ethnomathematics-based e-learning and students' creative thinking abilities and learning outcomes in the pre-test and post-test between the Experimental and Control classes

	Variable	Groups	Category	Mean	Min	Max	N	%
Pre-test	Learning outcome	Experiment	Enough	16.7	12	36	40	46.0
		Control	Enough	14.2	13	35	40	43.7
	Creative thinking ability	Experiment	Enough	17.5	14	36	40	47.2
		Control	Enough	15.4	12	34	40	44.5
Post-test	Learning outcome	Experiment	Good	25.6	12	36	40	65.0
		Control	Enough	20.4	13	35	40	45.7
	Creative thinking ability	Experiment	Good	27.3	14	36	40	67.5
		Control	Enough	18.7	12	34	40	46.5

The results of the study shown in Table 4 show a significant increase in creative thinking skills and student learning outcomes after implementing ethnomathematics-based e-learning in the experimental group compared to the control group. Before the treatment, the average pre-test score in the experimental group for creative thinking skills reached 47.2% ($M = 17.5$), and the learning outcomes reached 46.0% ($M = 16.7$). Meanwhile, the control group showed an average creative thinking ability score of 44.5% ($M = 15.4$) and learning outcomes of 43.7% ($M = 14.2$). This indicates that before the intervention, both groups had relatively the same level of ability and learning outcomes. After treatment, the experimental group experienced a significant increase, with an average post-test score of creative thinking skills reaching 67.5% ($M = 27.3$) and learning outcomes of 65.0% ($M = 25.6$). In contrast, the control group only experienced a slight increase, namely creative thinking skills of 46.5% ($M = 18.7$) and learning outcomes of 45.7% ($M = 20.4$). The more significant increase in the experimental group indicates the effectiveness of ethnomathematics-based e-learning in improving creative thinking skills and student learning outcomes.

According to previous research, ethnomathematics offers a learning approach relevant to the local cultural context, helping students relate mathematical concepts to everyday life, thereby increasing creativity and conceptual understanding (Jaudinez, & Joaquin, 2023; Arsyam et al., 2024; Payadnya et al., 2024). This is also supported by Astuti, Wijaya, & Hanum (2024), who state that technology-based learning provides a more interactive and contextual learning experience, ultimately positively impacting student motivation and learning outcomes. Creative thinking skills include several important aspects such as fluency, flexibility, originality, and elaboration in thinking. E-learning based on ethnomathematics supports the development of these aspects by providing learning activities that allow students to explore new ideas, find relationships between concepts, and create creative solutions based on local culture. For example, in the material on flat shapes of squares and triangles, students are invited to analyze patterns in batik or calculate symmetry in traditional house architecture to understand mathematical concepts and foster creative thinking skills.

The increase in student learning outcomes in the experimental group also shows that e-learning based on ethnomathematics can improve students' understanding of learning materials. Electronic-based learning media has the advantage of providing more varied and interactive content, thus helping students understand the material better (Skulmowski & Xu, 2022; Yan et al., 2024; Alias & Razak, 2025). In addition, the use of digital applications in e-learning also offers easy access and learning flexibility that supports independent learning. Overall, these findings strengthen the view that e-learning based on ethnomathematics improves creative thinking skills and student learning outcomes. This aligns with the concept of 21st-century learning, which emphasizes the importance of creativity, critical thinking skills, and adaptability in facing global challenges. Thus, ethnomathematics-based e-learning can be an alternative learning media that is innovative, effective, and relevant in improving the quality of education in the digital era.

Table 5. Independent sample t-test

	T	df	Mean	Std.Deviation	95% confidence interval	
					Lower	Upper
					Creative Thinking Ability	14.426
	14.426	97.178	2.5242	.30052	15.521	.8720
Learning outcome	13.921	80	3.1615	.22018	16.462	.6240
	13.921	96.214	2.4132	.30018	14.227	.8325

The statistical test results in Table 5 show a significant difference in creative thinking skills and student learning outcomes between the group using ethnomathematics-based e-learning and the control group. The t-value for creative thinking skills is 14.426, and for learning outcomes, it is 13.921, much higher than the t-table of 1.990 at a significance level of 0.05 with degrees of freedom (df = 80). Following the hypothesis testing criteria according to Cramer (2003), when the t-value exceeds the t-table, the null hypothesis (H0) is rejected, indicating a significant difference between the two groups. The average (mean) value of students' creative thinking skills is 3.2726 with a standard deviation (Std. Deviation) of 0.20148, indicating that ethnomathematics-based e-learning positively affects the development of students' creative thinking skills. The 95% confidence interval, with a lower limit of 16.125 and an upper limit of 0.6342, shows a narrow range of values, providing high confidence that the results are consistent and significant. In learning outcomes, the average value (mean) of 3.1615 with a standard deviation of 0.22018 also shows a positive effect of using ethnomathematics-based e-learning. The 95% confidence interval, with a lower limit of 16.462 and an upper limit of 0.6240, shows a narrow range and high consistency of results. This increase in learning outcomes aligns with Lim, Whitehead, & Choi (2021) findings that electronic-based learning media can provide interactive and varied content, making it easier for students to understand the material.

Based on the study's results, ethnomathematics-based e-learning has been proven effective in improving students' creative thinking skills. According to Weiss & Wilhelm (2022), creative thinking skills include fluency, flexibility, originality, and elaboration. E-learning based on ethnomathematics supports these aspects by providing activities that allow students to explore new ideas, discover patterns, and create creative solutions in the context of local culture. Sunzuma, & Maharaj (2020) research also shows that ethnomathematics provides a contextual learning experience so that students can better see problems from various perspectives and generate innovative ideas. Implementing this e-learning allows students to learn through multiple simulations, interactive videos, and adaptive quizzes, which not only increase motivation but also help students relate mathematical concepts to real life, such as batik patterns or symmetry in traditional architecture. E-learning provides flexibility in learning, allowing students to learn according to their own pace and learning style. This is in line with the findings of Balalle (2024), which state that technology-based learning increases student engagement in the learning process.

The novelty in this study lies in integrating ethnomathematics with Lampung cultural design into online Scrabble game-based e-learning. This innovation not only presents interactive and adaptive learning but also connects mathematical concepts with local cultural contexts, providing students with contextual and relevant learning experiences. Previous studies have focused more on cognitive aspects and rarely discussed the influence of local culture in mathematics learning. Through this approach, students gain mathematical knowledge and learn local cultural values, strengthen cultural identity, and increase pride in local heritage (Dabamona et al., 2021; Habiburrohman et al., 2024). The implications of this study are vast, especially in the context of 21st-century education, which emphasizes creativity, collaboration, critical thinking, and communication. For teachers, this e-learning offers a creative learning method that can increase student engagement in the learning process. This learning media can be a model for schools to develop a curriculum based on local wisdom and technology. Meanwhile, for policymakers, this study shows the importance of supporting innovative learning media development that improves learning outcomes and strengthens local culture. In addition, the practical implications can also increase students' learning motivation by providing interactive content, such as videos, animations, and adaptive quizzes that provide an active learning experience.

Although it makes a significant contribution, this study has several limitations. The sample coverage involving only 80 students from one school and the limited application to number material in mathematics can affect the generalization of the research results. In addition, the research method that only uses a quantitative approach results in a lack of exploration of qualitative aspects of students' learning experiences. Further research is expected to expand the scope of research subjects, cover various subjects, and use a mixed methods approach to obtain more comprehensive results. Further studies should also consider external factors, such as technology accessibility and students' digital literacy, which may affect the effectiveness of e-learning.

Based on the results of this study, several recommendations can be considered. First, teachers and educators are advised to utilize ethnomathematics-based e-learning as a learning medium to improve student creativity and learning outcomes. Second, further researchers are expected to explore the application of ethnomathematics-based e-learning in various subjects and other cultural contexts to expand its benefits. Third, schools and education policy makers must provide support by providing technological infrastructure and teacher training in using electronic-based learning media. Fourth, further research is needed to test the effectiveness of this e-learning in the long term and see its impact on students' affective and psychomotor aspects. Thus, ethnomathematics-based e-learning is an innovation in mathematics learning and an essential tool in building students' character and cultural understanding in this digital era.

CONCLUSION

The results of this study indicate that the use of ethnomathematics-based e-learning with Lampung cultural design nuances significantly influences students' creative thinking skills and learning outcomes. This is evidenced by the t-value for creative thinking skills (14.426) and learning outcomes (13.921), which

are higher than the t-table (1.990) at a significance level of 0.05, which indicates a significant difference between the experimental and control groups. The experimental group showed an average increase in creative thinking skills of 67.5% and learning outcomes of 65.0%, much higher than the control group. This increase indicates that ethnomathematics-based e-learning enriches the learning process and creates an interactive and relevant learning environment with local culture to increase students' motivation and involvement in learning. This ethnomathematics-based e-learning can be an alternative learning media that is effective, innovative, and relevant in supporting 21st-century learning that emphasizes creativity, critical thinking skills, and adaptability. In addition, this approach also contributes to preserving local culture, especially Lampung culture, through integrating cultural values in formal learning.

Regarding education policy, these findings support the development of a local wisdom-based curriculum, where each region can develop contextual teaching materials tailored to local cultural characteristics. This also opens up opportunities to implement the concept of ethnomathematics in other subjects, enrich cross-disciplinary learning, and strengthen students' cultural identities in a global context. In the future, further development can be focused on improving interactive e-learning features, such as multimedia or game-based learning, to increase student engagement further. In addition, additional research is also needed to measure the effectiveness of this media in various levels of education and learning contexts so that the results can be used as references on a broader scale.

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